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AEROBIC WORK CAPACITY IN YOUNG SEDENTARY MEN AND ACTIVE ATHLETES IN INDIA

S. K. VERMA, MSc*, L. S. SIDHU, PhD**
and D. K. KANSAL, MSc*

*Senior Research Associate, Department of Human Biology, Punjabi University, Patiala

**Reader, Department of Human Biology, Punjabi University, Patiala

ABSTRACT

Maximal oxygen uptake ($\dot{V}O_2$ max) was determined in 40 sedentary men aged 17-25 years and in 96 active athletes of the same age participating in 5 different kinds of sport. The $\dot{V}O_2$ max in the sedentary group was found to be 36.8 ± 4.0 (SD) ml.kg.$^{-1}$ min^{-1}. The results in the sedentary group were found to be lower than those recorded on inactive populations in other countries by 12-35%, possibly due to the low participation rate in sport among Indians. The mean $\dot{V}O_2$ max in 96 active athletes was 48.4 ± 5.1 ml.kg.$^{-1}$ min^{-1} which is slightly low as compared to $\dot{V}O_2$ max values recorded in active populations in other countries. The difference in the mean $\dot{V}O_2$ max of sedentary group and that of the active one was found to be statistically significant. The highest mean $\dot{V}O_2$ max was recorded in the group of long distance runners (56.4 ml.kg.$^{-1}$ min^{-1}) while lowest mean $\dot{V}O_2$ max values were recorded in the group of football players (44.2 + 2.1 ml.kg.$^{-1}$ min^{-1}).

INTRODUCTION

The general fitness of a population is influenced by such factors as nutrition, environmental conditions, ethnic origin, age and habitual activity. For instance, the increase in modernisation as a result of advancement in technology, has consequently resulted in the decrease in the physical activity required in daily life. The difference in the physical fitness standards may well be ascribed to the above factors, discussed by many authors, such as Åstrand and Rodahl (1970), Cotes et al (1969), Davies et al (1972), Glick and Schvartz (1974), Hermansen and Andersen (1965), Koniz et al (1961), Matsui et al (1972) and Taylor et al (1955). The ability of an individual to perform aerobic work at maximal levels (an important aspect of physical fitness), is measured by the determination of maximum oxygen uptake, as described by Åstrand and Rodahl (1970), Shephard et al (1968) and Taylor et al (1965).

There are very few studies regarding maximum oxygen uptake in Indian athletes, though results have been reported by Malhotra et al (1972a and b), and by Verma et al (1977 and 1978). No comparable studies could be found on sedentary Indian men. These studies are not adequate to allow a full statistical comparison with the results obtained on active athletes and sedentary subjects from other countries but some interesting information has been gathered (Table III). In the present study, the aerobic work capacity of 40 sedentary young men aged 17-25 years and of 96 active athletes of the same age range was investigated. The data obtained on these subjects of a developing country like ours, may serve as a basis for comparison of the aerobic work capacity of the sedentary and active populations in India with those of other developed or developing countries.

MATERIAL AND METHODS

96 healthy athletes aged 18-25 years, and 40 sedentary healthy young men of the same age, were examined. The subjects in the second group had sedentary occupations — most were office workers and students. None had participated in physical training programmes for at least 2-3 years prior to examination. The sedentary subjects examined were from the Patiala district in the Punjab, while the healthy athletes studied participated in active programmes and were in training at the Netaji Subhash National Institute of Sports and hailed from different states of India. Because of certain unavoidable circumstances the collection of data on sedentary subjects was restricted to the Patiala region, so in the present study the aerobic work capacity of sedentary Punjabis has been compared with active athletes from all India.

Maximum oxygen uptake of all the active athletes and 16 of the sedentary subjects (out of a total of 40) was determined by a progressive step increment test using an electronically controlled cycle ergometer. The exercise test was started at a light work load of 50W. Every 3 minutes thereafter the work load was increased by 30W until the subjects stopped pedalling. During the test each subject was encouraged verbally, and motivated to pedal for as long as possible. The test was terminated when the subject could no longer turn the pedals. Subjects breathed through a dry gas meter during exercise and expired air samples were collected at the end of each work load. The gas samples were analysed for percent

CO_2 and O_2 using Haldane's technique. Max $\dot{V}O_2$ was chosen as the highest observed oxygen value in the series of consecutive O_2 measurements.

$\dot{V}O_2$ max of 24 sedentary subjects (out of a total of 40 studied) was estimated according to Åstrand's nomograms (1970) by the determination of submaximal heart rate on an electronic controlled cycle ergometer. Each subject underwent two 5-min tests at a rate of 50 rev/min. The work load in the first test was 50W and the second test was adjusted to give a heart rate of between 125 and 170 beats/min. All the measurements were taken indoors. None of the subjects had a heavy meal or smoked cigarettes prior to examination.

RESULTS

The average values of $\dot{V}O_2$ max and body weights of the sedentary subjects and active athletes are presented in table I. The mean $\dot{V}O_2$ max of the 40 sedentary subjects (17-25 years) was found to be 36.8 ml as compared to 48.4 ml for the active athletes of the same age. The differences in the mean values of $\dot{V}O_2$ max between the sedentary subjects and active athletes was found to be statistically significant ($P < 0.001$).

TABLE I

Weight and maximal oxygen uptake in 40 sedentary and 96 active sportsmen aged 17-25 years

Activity	No. of subjects	Weight (kg)	$\dot{V}O_2$ max ml.kg.$^{-1}$ min.$^{-1}$
SEDENTARY	40	57.9	36.8 ± 4.0 (SD)
ALL ACTIVE	96	58.9	48.4 ± 5.1 (SD)
Football	29	57.6	44.2 ± 2.1 (SD)
Hockey	26	60.5	48.0 ± 3.3
100-400m Runners	13	62.3	49.6 ± 2.6
Volleyball	17	58.8	50.3 ± 3.9
800-10,000m Runners	11	54.9	56.4 ± 2.5

The average values are also given according to the type of sport. The 800-10000m runners were found to possess the highest mean value of $\dot{V}O_2$ max 56.4 ± 2.5 (SD) followed by volleyball players (50.3 ± 3.9), 100-400m runners (49.6 ± 2.6), hockey (48.0 ± 3.3) and football players 44.2 ± 2.1 ml.kg.$^{-1}$ min^{-1}. The values of 't' indicate that in most of the sportive categories significant differences exist in $\dot{V}O_2$ max except when the 100-400m runners are compared with the hockey and the volleyball players (Table II). The lowest mean value of weights were recorded for the long distance runners (800-10,000m) in whom, the highest $\dot{V}O_2$ max scores were observed. The footballers were found to possess the lowest mean value of $\dot{V}O_2$ max.

TABLE II

Value of 't' along with their probability

Comparison of $\dot{V}O_2$ max between	't'	P
Football/Hockey	−5.14	<0.001
Football/Volleyball	−6.86	<0.001
Football/100-400m Runners	−7.19	<0.001
Football/800-10,000m Runners	−15.96	<0.001
Hockey/Volleyball	−2.06	<0.05
Hockey/100-400m Runners	−1.43	>0.10
Hockey/800-10,000m Runners	−7.68	<0.001
Volleyball/100-400m Runners	0.57	>0.10
Volleyball/800-10,000m Runners	−3.44	<0.002
100-400m & 800-10,000m Runners	−6.68	<0.001

DISCUSSION

The mean value of $\dot{V}O_2$ max of young sedentary men aged 17-25 years, in this study has been found to be 36.8 ml.kg.$^{-1}$ min.$^{-1}$, which is probably the lowest in comparison with similar reports in literature. On comparing the $\dot{V}O_2$ max of our young sedentary subjects with similar reports from developed countries such as Sweden (Åstrand, 1952), the U.S.A. (Taylor et al 1955), Germany (Koniz et al 1961), Britain (Davies et al 1972) and Canada (Robinson et al 1941), the mean value of $\dot{V}O_2$ max is found to be lower by 12 to 35% (Table IIIA). Since $\dot{V}O_2$ max is regarded as representing cardiopulmonary fitness (Taylor et al, 1955), it may therefore be noted that the physical fitness of Indian Punjabi boys aged 17-25 years is relatively low in comparison with that of young people in developed countries. If $\dot{V}O_2$ max is determined by the direct method, the mean value is raised by 10 to 15% (Åstrand and Rodahl 1970, Glick and Schvartz 1974, and Wyndham et al 1966), but this is still not sufficient to explain the low mean $\dot{V}O_2$ max recorded in this study. We have used an indirect method of predicting $\dot{V}O_2$ max from heart rate during submaximal work loads (Åstrand and Rodahl 1970) for 24 of our sedentary subjects, while direct method has been used for rest of the subjects of this study. In most of the studies, indirect method has been preferred to estimating $\dot{V}O_2$ max, because it is reliable and practicable for mass screening. Therefore, it may be added that the low values of $\dot{V}O_2$ max obtained for sedentary subjects in this study, can not be attributed to the different methods used for the determination of $\dot{V}O_2$ max. The markedly low $\dot{V}O_2$ max in young Indian sedentary subjects than the sedentary boys of the same age from other countries, is probably due to low participation in sport among the former. Other factors like nutritional status, environmental and genetic factors may also be responsible for this.

Discussing the intersport differences in the $\dot{V}O_2$ max it appears that the differences in the maximum oxygen uptake between the various categories of athletes agree

with the demands of the particular activity. For instance, the long distance runners require continuous hard physical activity which lasts for a very long period. It is generally accepted that the capacity to consume oxygen is of capital importance as far as heavy prolonged work is concerned and high aerobic capacity makes possible a high energy output for a long period of time. The 800-10,000m runners in the present study have shown significantly higher mean value of $\dot{V}O_2$ max and relatively low body weights as compared to all other categories of athletes, which is of definite advantage to the runners for endurance or prolonged work. The football players were found to possess significantly low mean values of $\dot{V}O_2$ max as compared to all other categories of athletes. Football requires short bursts of vigorous muscular activity followed by breaks of slow activity. Energy under such circumstances can be supplied mainly through anaerobic means. Our previous studies (Verma et al 1977) have revealed that footballers possess greater anaerobic muscular power as compared to other categories of sportsmen like hockey and basketball players and long distance runners. Hence it is understandable that the differences in the physiological status of the players agree greatly with the demands of the particular activity.

The comparison of $\dot{V}O_2$ max of active athletes of the present study with similar reports from other countries (Hermansen and Andersen 1965, Ikai and Shindo 1967a and b, and Shoenfeld et al 1977). (Table IIIB) reveals that the $\dot{V}O_2$ max of our athletes is slightly low. The results in our group of active athletes were found to differ greatly from those of a series of professional athletes investigated by Saltin and Åstrand, 1967 – the mean $\dot{V}O_2$ max was found to be 60 ml.kg.$^{-1}$ min^{-1}. However it may be added that the subjects of their study were top athletes and world record holders and some of them were participants in such high endurance sports as skiing.

The comparison of $\dot{V}O_2$ max of the different categories of athletes like footballers, volleyballers, runners and hockey players studied in the present paper with the $\dot{V}O_2$ max of their counterparts from other countries reveal that the Indian athletes possess comparatively low values of physical work capacity. This suggests that any succeses of the Indian teams may be attributed to their higher levels of skill rather than to their $\dot{V}O_2$ max. Hence, it further strengthens the need to improve the physical fitness standards of our active athletes.

TABLE III

Comparison of maximum oxygen uptake in different groups of populations

		Age (Years)	$\dot{V}O_2$ max (ml.kg.$^{-1}$ min.$^{-1}$)	Reference
A	**INACTIVE POPULATIONS:**			
	American (U.S.A.)	10-17	49	Morse et al 1949
	Swedish	12-20	57.8	Åstrand 1960
	German	10-19	46	Koniz et al 1961
	Israeli	18	38.4	Glick & Schvartz 1974
	American (U.S.A.)	18-30	43.5	Taylor et al 1955
	Norwegian	18-30	44	Hermansen & Andersen 1973
	Swedish	18-30	58.6	Åstrand 1952; Åstrand & Rodahl 1970
	Bantu	18-30	44.6	Davies et al 1972
	British	18-30	41	Watson & Devenney 1972
	Yoruba (Nigerian)	18-30	45.9	Davies et al 1972
	Canadian	18-30	44.5	Robinson et al 1941
	Japanese	18-30	45 to 55	Ikai & Shindo 1967a & b; Matsui et al 1972
	Israeli	18-30	40	Glick & Schvartz 1974
	Indian	17-25	36.8	Present study 1979
B	**ACTIVE POPULATIONS**			
	Lap	18-30	54	Andersen 1967
	Bantu & Bushman	18-30	50	Wyndham et al 1966
	Yoruba	18-30	55.5	Davies et al 1972
	American (U.S.A.)	18-30	50	Ikai & Shindo 1967; Taylor et al 1965
	Israeli	18-30	54.8	Shoenfeld et al 1977
	India	17-25	48.7	Present study 1979

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